IRISH INVESTIGATION ON THE LOBSTER (*HOMARUS VULGARIS* Edw.)

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Commercially the lobster (*Homarus vulgaris* Edw.) is the most important shellfish in Ireland. The Irish coast is deeply indented, except on the east, and is well suited for the exploitation of lobsters. Even on the east coast amidst a predominantly sandy shoreline, a number of discreet areas are fished actively.

Lobster fishing was once largely a part-time occupation of fishermen farmers. Since 1935 an ever increasing proportion of the catch has been taken mainly during the summer by boats using gear especially adapted for lobster fishing to the exclusion of other activities. This trend owes much of its development to the expansion of the English and particularly the Continental markets. Progress since 1947 has been rapid in the case of crawfish (*Palimuris vulgaris* L.) fishing. Crawfish in Ireland are linked with lobsters, because of the similarity of fishing methods. Thus, both species, where they occur together, have been exploited side by side. Lobster and crawfish landings since 1939 are given in Fig. 1, which shows the marked development in catches of the latter species.

The peak of the landings was in 1959. This coincided with the longest period of fine summer weather for over 20 years, during which time the landings have fluctuated considerably. Good and bad brood years must affect the landings, but the magnitude of the catch is influenced by weather to a considerable extent. Consequently, poor summer weather fortuitously conserves the stocks, inasmuch as it has

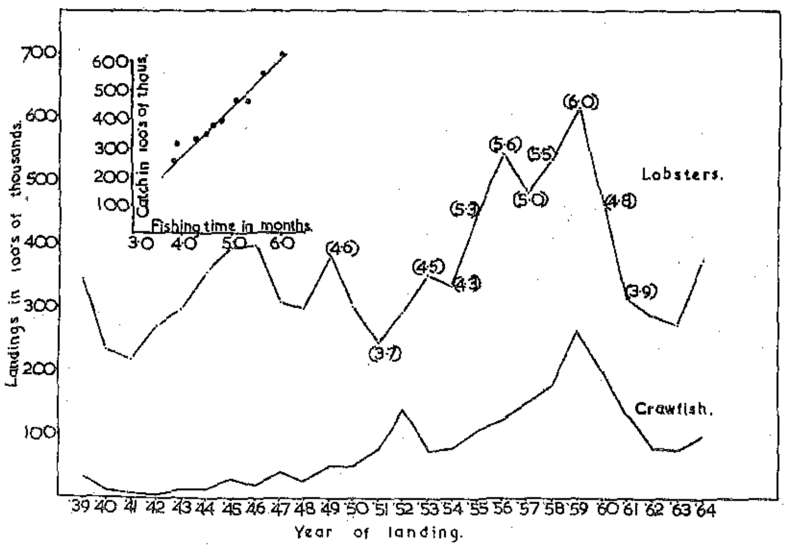


Fig. 1

The catch of lobsters and crawfish off the Irish coast from 1939 *to* 1964. *Figures in brackets are total time, in months, spent fishing. Inset is shown an apparent ascending relationship between time available for fishing and catch.*

a definite limiting effect on effort. The bracketed numbers in Fig. 1 indicate the mean duration of lobster fishing in months, for the particular years, where records are available. The indication here is that when the time available for fishing is short, as in 1951 and 1961, the catch is low, and alternatively when it is long, as in 1956 and 1959, the catch is high. The catch for 1959 was a record for the whole period 1939 to 1964. Less time in 1959 was lost taking fishing gear ashore, than in any of the other years. Unfortunately, catch effort statistics are not available for the whole coast so that break-downs of the landing figures are not possible.

The relationship between the catch and time spent fishing is also shown in Fig. 1. Whilst this can only be regarded as approximate it does suggest a linear relationship between time spent fishing and the yield of lobsters. This suggests that the maximum sustainable yield has not yet been reached. There has been no radical change in the total number of lobster pots or creels in use around the coast since 1949.

Clearly it is undesirable that the protection of the stocks should depend upon the limiting effects of weather. Detailed information available for certain areas indicates that fishing effort may be approaching, though it has not yet reached, that point when recruitment ceases to keep pace with catch and natural mortality. However, for the coast as a whole, the stocks remain underexploited. In areas such as Dalkey, Co. Dublin, Kilmore Quay, Co. Wexford, Dunmore East, Co. Waterford, Sligo and Donegal Bays, the mean size of the lobsters landed has steadily dropped during recent years. In the past, it has been usual for Irish lobster fishermen to exploit well defined areas of rock outcrops identified either visually or from trawling operations. However, in more recent years, with the aid of electronic equipment, hitherto unfished and unknown areas of rocky sea bed have been utilised. More data on the relationship of catch and effort to the length distribution of the landings are required, if a knowledge of stock abundance is to keep pace with expanding exploitation. In the Canadian fishery, Wilder (1954), found an apparent protection to be afforded to the stocks by the observance of a size limit. The present size limit introduced in May, 1963, for male and female lobsters in Ireland, is 83 mm., measured in a straight line from the back of the eye socket to the distal margin of the carapace. This gives an effective mean overall measurement of 23.9 cm for males and females, (approx. 9.4 inches).

Dow (1964) has shown that the maximum sustainable yield in the Maine fishery is 22 million lbs., and that providing this upper limit is not exceeded, the fishery will remain stable, irrespective of either seasons or size limits.

The size of boats used for lobster fishing in Ireland varies greatly, from 4.3 m (14 feet) punts and currachs to boats 18.5 m (60 feet), used as seiners or trawlers in winter time. Punts and currachs are often hand operated and fishing them is a part-time occupation in many cases. Since 1949 there has been a reduction of about 45% in the number of punts, and from about 1956 onwards there has been an increase in the use of motorised vessels designed and operated for lobster or crawfish fishing.

Three standard patterns of lobster trap are in use, each with local variations. The Kilmore Quay pattern is locally called a *pot*. It is a very successful adaptation of the traditional wicker "inkwell" shaped lobster pot. It has an improved design, and being constructed of metal, except for the neck, has a long life. The French crawfish creel is the most popular gear in use. There are also many variations of the Scottish creel in use. The latter design is regarded as being very efficient though it is generally accepted that metal creels have the important asset of outlasting all timber varieties. The size of the eye, or entry point, leading to the neck varies. In the case of the crawfish creel it is usually about 28 cm (11 inches); in the Kilmore Quay pot it is 15 to 18 cm (6 to 7 inches) whilst in the Scottish creel it may be as low as 11 cm(4½inches) or as large as 18 cm (7 inches). There is considerable difference in the effort demanded by various fishing gears. In the case of the Kilmore Quay pot, best results are obtained by hauling them once, or at most, twice per day. Some of the smaller eyed Scottish creels are fished only once per day but most are fished twice. In all cases best catches are obtained at dawn and dusk. The crawfish creel produces a progressively greater catch with the number of times the gear is fished. In effect this means that it can produce more lobsters at the cost of greatly increased effort.

In a small minority of places, e.g. Dalkey, Co. Dublin, the gear, when weather permits, is fished all the year round. There have been only a small number of isolated efforts to use heavy gear capable of withstanding the effects of storms during winter and spring. It is interesting to note that in those few places where a late autumn and early winter fishery takes place, that the catches at that time are (a) surprisingly large and (b) consist chiefly of post recruit lobsters, i.e. those of 24 to 25 cm (9½ to 10 inches).

A variety of bait is used, including flat fish (whole), flat fish (the frame after filleting), gurnard, pollack, mackerel, herring, etc. Opinion is divided as to which is the most effective. There is general agreement that the bait must be firm and, therefore, difficult to dislodge. For this reason and to speed rebaiting of pots during fishing, the Kilmore Quay fishermen secure their baits with lengths of wire and keep them in a tub on board ready for immediate use. This is an easy and efficient system, saving much time and labour.

Ireland's chief markets for lobsters are in Belgium, Germany, England, France, Holland and Switzerland. To ensure that lobsters of best quality arrive in these markets, so far away from their place of capture, specialised handling and storage techniques have been devloped. Fishermen are aware of the need to handle their catch with care. Upon them rests the main responsibility of determining the ultimate quality of the marketed lobster. They have abandoned the use of "plugs" for immobilising the chelipeds, and now use either rubber bands or string for this purpose. The catch is protected from the elements whilst aboard ship; exposure to evaporation by the sun or dessication by the wind being especially avoided. Once in port, the catch is placed in floating keep boxes through which an adequate current of seawater flows. These boxes usually contain a week's catch. They vary in capacity up to approx. 100 Kg. (about 2 cwts.). As much as 85% of all lobsters landed are "stored" in one of four basic types of storage unit. These units are: —

(a) Very large floating boxes;

(b) Controlled tidal ponds;

(c) Recirculation and

(d) High density storage units.

High density storage units were developed by the Fisheries Division of the Department of Agriculture and Fisheries and though of small capacity (ca. $\frac{1}{2}$ to 1 ton) they can be operated in urban areas and have a high turnover rate. Mainly because the conditions in large floating boxes are not ideal for keeping lobsters alive, they are disappearing. Tidal ponds are used successfully where the sea runs strongly and is unaffected by fresh water. Recirculation ponds, often situated well above sea level, have proved to be most successful, especially when direct circulation from the sea and back to it, is possible. Storage of lobsters in Ireland is discussed elsewhere (Gibson 1959).

A considerable part of the catch of lobsters is transported directly to the Continent by well-boat, and an increasing number are taken by air to Britain and the Continent.

Modern lobster studies were commenced in Ireland in 1957 on inter alia, length distribution, sex ratios, ecdysis, tagging, mortalities, maturities and pathology. At first, the work was distributed over a number of areas, but subsequently it was concentrated at Dalkey, Co. Dublin, and Kilmore Quay, Co. Wexford. Dalkey is a small harbour, from which three or sometimes four motorised punts fish around Dalkey Island and the Muglin Rocks. About 80 to 100 lobster creels fish in a small area. Approximately 3,500 lobsters are landed in an average year. No crawfish are landed at Dalkey. Kilmore Quay, a small port on the south Wexford coast, is the landing place for lobsters caught mainly around the Saltee Islands, the Coningsbeg rocks and Kilmore Quay itself. Upwards of 1,000 lobster pots and creels are fished from April to September in this area, where the annual catch has been as high as 52,000, taken by boats ranging from punts to 55 foot boats. The number of crawfish landed is negligible.

It is of interest to note the distribution of crawfish around the Irish coast. They are rare from Carlingford Lough to Carnsore Point along the east coast (Gibson and O'Riordan, 1964). They are common along the south coast from Carnsore Point to Dursey Island, and especially around the coast of County Kerry. From the mouth of the River Shannon to Donegal Bay they are common though localised, whilst north of Donegal Bay they are uncommon. Olsen (personal communications) states that the geological projection of land masses into the sea has a bearing on the incidence of crawfish. In areas of low coastline, crawfish are scarce, an observation which more or less fits in with their distribution around the Irish coast, and may actually govern their development.

Relationship of Size of Catch to Gear

In 1957 differences in the size of lobsters caught by gear having varying sized eye apertures were studied. Table 1 sets out the results from four centres.

Clearly the average size for Co. Kerry is somewhat greater than that for the other areas. Using the Bartlett criterion it has been found that the difference between the variances is decidedly significant, i.e. 61.18 where at the 0.1 per cent level the significance level expected is 16.266. However, the mean square between area means, 47.22, is so strikingly in excess of the average mean square within areas, 1.84, that there can be no doubt but that the means of carapace and, therefore, total lengths differ between areas. This suggests a number of possibilities, firstly, that the smaller the eye the more readily a large lobster may be prevented from entering; secondly, perhaps the reported "lobster hierarchy" plays a part whereby when large lobsters enter a creel, smaller lobsters tend not to associate themselves with such creels. Alternatively, it may be that the County Kerry lobsters were larger because the gear in which they were taken is fished in deeper water and over a greater area than elsewhere. In 1959. a further trial was made using Kilmore Quay type pots, Scottish creels and French crawfish creels within the Kilmore lobster fishery. The tests were run over a period of 9 weeks from June 25 to August 28. One dozen of each type of lobster gear were randomly placed and the catch data were logged. The average carapace length of lobsters from the Kilmore type pots was 9.6 cm., from Scottish creels 9.4 cm. and from French crawfish creels 9.3 cm. These means did not appear to suggest a significant difference in the size of lobster caught by the three gears which had 17.8 cm (7″), 15.2 cm (6″) and 27.9 cm (11″) openings, respectively. However, tests comparing the catch by Kilmore Quay pots and French creels gave a difference in length distribution of the catches significant at the 0.01 level, and similarly between the Scottish and French creels. The difference in length of lobsters caught by the Kilmore Quay pots and Scottish creels was barely significant. In these data the mean size of lobsters taken by the French creels was the smallest. This suggests that the size of eye is not an important selection factor. The stocks of lobsters around the Kerry coast may be more abundant, due to the dominance there of crawfish fishing, which in itself would reduce the number of lobsters caught and explain their larger mean size. Conversely the concentrated lobster fishing off Waterford, Wexford and Dublin would account for the smaller mean size of the landings. Therefore, it seems that where fishing gears of different types have the same opportunity to attract lobsters, those with the largest eye openings may in fact catch the smallest lobsters, at a significant level. The Dalkey creels have by far the smallest eye apertures, and yet the mean size of the lobsters taken by them is larger than that for Wexford and Waterford, where there is greater fishing effort. In turn the Dublin area is more intensively fished than Kerry. It would appear, therefore, that the diameter of the eye opening cannot have any general application as a conservation measure, having no absolute correlation to mean size, at least within the limits of that part of a lobster population forming the commercial catch. A suitable field of study here lies in the exact mechanism of escapement from traps of all kinds. Presumably a close correlation exists between the size of lobster entering the gear and escaping from it again via the spaces between the laths. It may be possible to relate the size of escapement to lath spacing, and this might lead to a very practical means of conservation (Wilder, 1954). However, an undesirable side effect from widening the lath spacing would be a likely increase in the number of maimed lobsters landed. If lobsters appendanges can pass freely through the lath spacing, then both on the sea floor and aboard ship the risk of their being trapped or crushed is high, especially during rough weather.

Growth

Growth in lobsters is complicated by the fact that moulting rates vary with age. Moulting takes place more frequently in young than in older lobsters. The Irish tagging data were used to estimate the increments due to moulting and annual growth rates.

Increment due to moulting. The lobsters recaptured in the tagging experiments (see pages 31 and 32) which during an absence of one to six months, could reasonably have been expected to have undergone only one moult, were segregated from the remainder. Their range of carapace length was from 8.6 to 11.7 cm. They were separated into males and females and regression equations were determined as follows:—

Males: Dalkey $l_n+1=0.95\ l_n+1.172$ cm
Females: Dalkey $l_n+1=0.95\ l_n+1.283$ cm
Kilmore $l_n+1=0.96\ l_n+1.191$ cm

The lines have been fitted to the observations in Fig. 2, where l_n is the length at liberation and l_n+1 is the length one moult later. It seems that males have a slightly greater incremental rate at moult than females. Too few Kilmore Quay males were recaptured to permit worthwhile calculations.

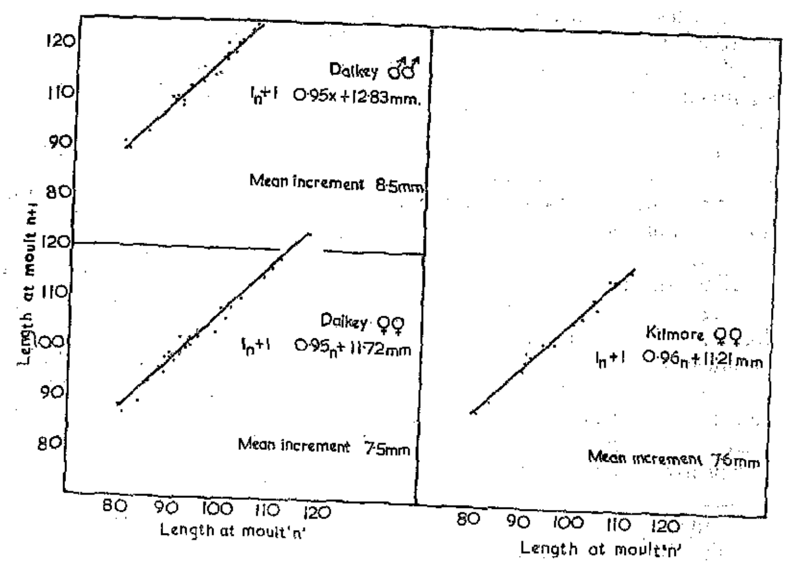


Fig. 2

Lines fitted by least squares to illustrate the increment per moult, within the size range of observed data, for males and females at Dalkey, and females only at Kilmore.

The coefficient of growth lies within the range 0.95 to 1.05, which suggests that the moult increment is nearly constant. This is confirmed by Hepper (1965, personal communication) in relationship to his experiments in England. Kurata (1962) describes this type of increment as "arithmetic" and points out that it is illustrated by Wilder's (1953) data for *H. americanus*.

Juvenile and adolescent growth patterns in *H. americanus* and *H. vulgaris* probably do not differ radically. Data for captive *H. americanus* (Bowers personal communication) produce a regression equation for successive moult increments as follows: —

$$1_n + = 1.15\ 1_n + 1.20 \text{ cm}$$

This is progessive growth and is based on observed sizes from 0.6 to 7.6 cm carapace lengths. It is interesting to note that at Dalkey, three females liberated at lengths of 7.8, 8.0 and 8.1 cm and making only one moult produced a regression coefficient which was not arithmetical. It is probable that these three females were immature and that their growth rate was still progressive. Little is known of first maturity in lobsters. In the Irish data the smallest observed ovigerous female was 7.2 cm in carapace length. However, 91.5% of females measuring 7.0 to 8.4 cm were not ovigerous. Little information is available of maturity in males, though it seems likely that they become mature earlier than the females. Simpson (1961) observes that the smallest mature female he examined was 7.7 cm in carapace length and stated that the 50% level of maturity could be expected amongst lobsters of 8.7 cm carapace length. All the observations of growth per moult in the Irish material are based on sizes about 8.6 cm and up to 11.7 cm carapace length. The growth per moult as interpolated from the equations thus takes no account of progressive growth rates prior to maturity. Large scale egg bearing commences between 8.5 and 9.0 cm and the length of time which females take to reach this is somewhat longer than that for males. Large females would thus be considerably older than equal length males and probably subject to higher natural mortality so that the observed upper limit of growth in males could be expected to be greater than in the case of females.

The time of year when moulting takes place is important. Whilst it is probable that extensive moults occur in mid-summer, the data point to considerable moulting at other times of year. For example, 8 lobsters caught early in the 1959 season constituted 26% of all recaptures in that year and clearly they had moulted in the period from April to June. Because they were all hardening or hardened when recaptured, it seems reasonable to suggest that the moult occurred in April or early May, which points to an appreciable part of the stock undergoing early ecdysis over a considerable size range in the year in question when sea temperatures were almost 2°C above average. Temperature is likely to be the governing factor over moult frequencies from year to year.

Annual Growth Rate

The annual increase in length will depend upon the number of moults. Those recaptured moulted lobsters which had been at liberty for 12 months were segregated and growth regressions calculated for them. That liberations were made at different times of the year, viz. March, June and July, and that moulted recaptures were not representative of the maximum number of moults in one year, must be recognised as a source of bias in calculating annual increments. However, since moulting is probably most frequent during or just after these months, the analyses are worthwhile, even if they only describe a minimal pattern of annual increment. The data given below is for males only as a satisfactory regression line could not be drawn for females. A small number of male lobsters did not moult during a year at liberty and these have been included. One such male had a carapace length of 12.6 cm which probably indicates the approximate size at which moulting becomes less than annual. The annual growth rate was found to be: —

$$l_t+1=0.88\ l+2.1143 \text{ cm}$$

If we use the notation (Beverton and Holt 1959) that, $l_t+1=e^{-k}\ l_t+L^{\infty}\ (1-e^{-k})$ then we can say that, $e^{-k}\ l_t=0.88$, and $L^{\infty}\ (1-e^{-k})=2.1143$ cm in the growth regression. By derivation we find that $K=0.1213$ and $L^{\infty}=17.43$ cm. In order to construct a growth curve which would have great accuracy, it would be necessary to have good observed length for age data, so that t_o could be estimated. In the absence of these observations, it is possible to utilise the growth equation where, $l_t=L^{\infty}(1-e^{-k}t)$. A curve based upon this formula is given in Fig. 3. The moult sizes have been fitted to this curve to show that the theory of constant moult increment fits in with de-

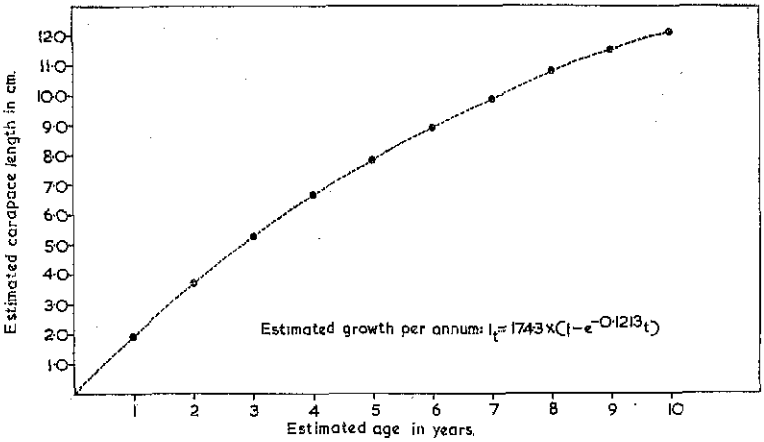


Fig. 3

Idealised annual growth curve based on derivation from von Bertalanffy equation.

creasing annual growth rates. It is not possible to read too much into this growth curve because it is a tentative attempt to age lobsters. It is suggested that the approximate age at which lobsters at Dalkey become fully recruited to the fishery is at the end of their fifth year of life. The limitations of this estimate of annual growth in male lobsters are well realised. However, it may be that other workers with more comprehensive data might obtain more dependable results using a technique of this kind.

For comparison there are figures given by Smith (1935) for rates of growth in captive lobsters at Port Erin, Isle of Man. The most comprehensive of the figures relate to females. The Irish estimate of growth has been based only on males. However, there is a suggestion that up to 8.5 cm carapace length (Fig. 4) there is little difference in the rate of growth between the sexes.

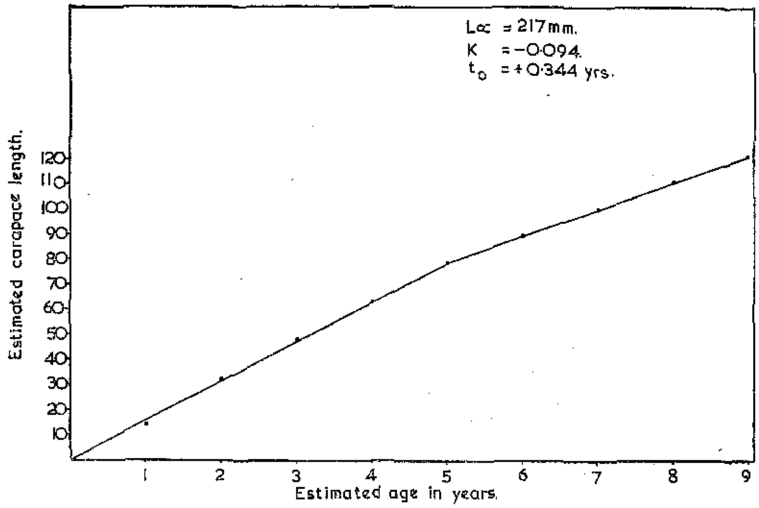


Fig. 4

Growth curve constructed from data of annual growth for female captive lobsters measured at Port Erin, Isle of Man.

The small number of observed age for length records of lobsters from the Isle of Man permits the three parameters of a growth curve to be calculated as follows (Fig. 4): $L^{\infty}=21.7$ cm, $K=0.094$ and $t_0=0.344$ years. The resultant curve has been built from the notation that $l_t=L^{\infty}(1-e^{-k(t_1-t_0)})$. A comparison of the estimates for Dalkey and the I.O.M. is set out below for both sexes combined.

	1st year	2nd year	3rd year	4th year	5th year	6th year
Port Erin	1.31 cm	3.15 cm	4.82 cm	6.33 cm	7.85 cm	8.96 cm
Dalkey	1.19 cm	3.76 cm	5.32 cm	6.70 cm	7.93 cm	8.97 cm

Too much stress cannot be laid upon the similarity of these two growth rates because the data are so meagre and the comparison is between an estimate for native unaged lobsters and captive lobsters living in idealised conditions. However, the general agreement found is of some importance in that it points to an apparently probable method of ageing given adequate material.

Mortality

The carapace length frequencies for males and females from Dalkey and Kilmore Quay are given in Figs. 5, 6 and 7 for the period reviewed and are based in all cases upon measurements of the total catch by a variety of boats on each occasion of sampling. There were 3,535 lobsters measured in the case of Dalkey, representing about 20% of the landings for the five years, and 7,352 lobsters at Kilmore Quay representing about 6% of the landings.

The Dalkey male frequencies (Fig. 5) indicate the importance of

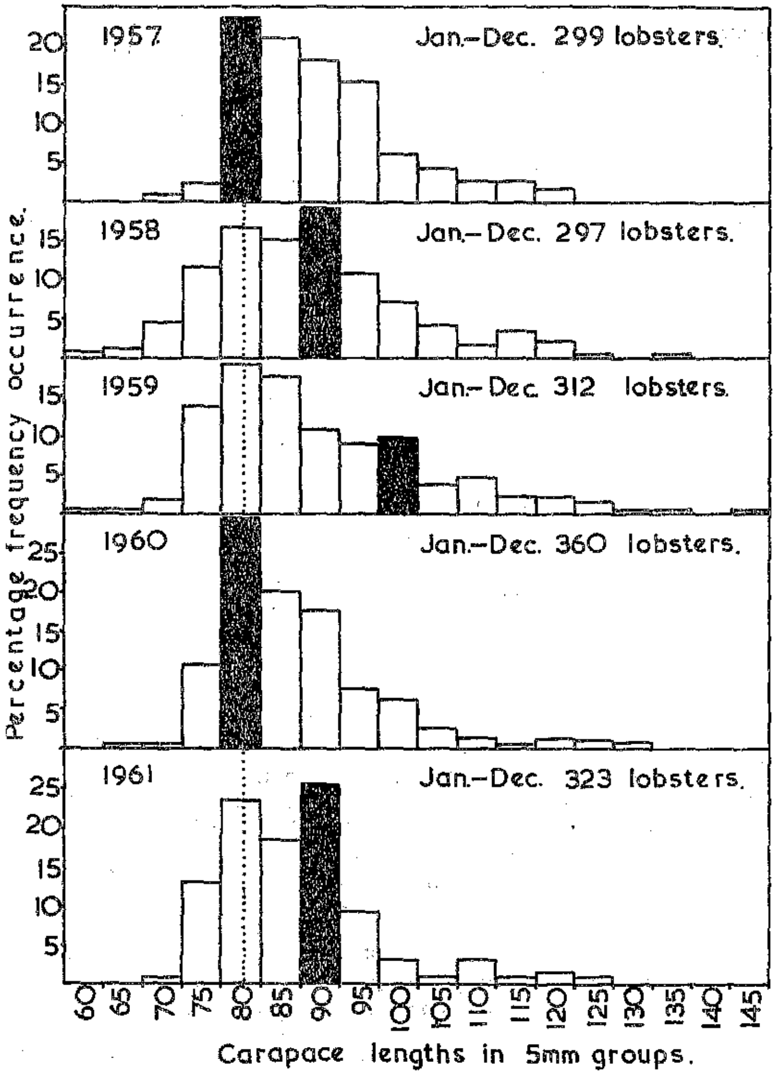


Fig. 5

Length frequency distribution of male lobsters at Dalkey (1957 *to* 1961). *Dotted line indicates the maximum legal size limit.*

recruitment and suggest that there may be a lasting effect of what is probably an age grouping. In 1957 the 8.0-8.4 cm, normally the most dominant in samples, was so strong as to become the dominant 9.0-9.4 cm length group in 1958. This 9.0-9.4 cm group appeared in 1959 as a well represented 10.0-10.4 cm group. These observations fit in with the order of expected increments discussed in the previous 1961 as a 9.0-9.4 cm group giving the distribution a double peak. The immediate impression given by the size distribution of males is that the fall off in numbers with age is not very marked. This is clearly shown by the Kilmore Quay male frequencies (Fig. 6), where

the peaks occur at 8.5 cm and continue slowly descending to 15.5 cm. At Kilmore Quay, the fishery is seasonal which accounts for the smaller representations of the 8.0-8.4 cm recruit group.
section. In 1960 the 8.0-8.4 cm group, which now might be regarded as the first fully recruited size group, once again was carried into

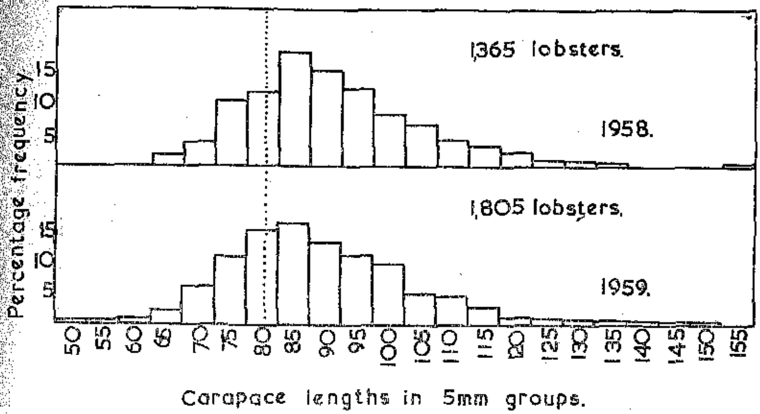


Fig. 6

Length frequency distribution of male lobsters at Kilmore Quay (1958 *and* 1959). *Dotted line indicates the minimum legal size limit.*

At Dalkey where the 8.0-8.4 cm group enters the fishery in late autumn, fishing continues at that time and so the recruits assume a dominant place in the samples (Fig. 5).

It is obvious that the extent and annual occurrence of these recruits is the mainstay of the lobster fishery, because presumably they form the basis of the catch for the succeeding summer. Thomas (1951) reported that the size distribution is constantly changing and attributes this to moulting. Some of the changes in annual size distribution, according to the present data, are due to the success or otherwise of recruit years.

The combined data for Dalkey have been separated into those relating to lobsters landed in the spring, summer and autumn (Fig. 8). In the summer there is a smooth curve without distinct peaks. In the spring and autumn peaks appear especially in the smaller size ranges. The "flattening" in the summer is probably caused by moulting. The dominance of the smaller lobsters at other times is a notable feature and a most important one to the stability of the stocks.

Males. The length frequencies of male lobsters at Dalkey and Kilmore Quay have been converted to age in Figs. 9 and 10 based on the growth curve (Fig. 3). The year of greatest fishing intensity was 1959 but the total mortality at Dalkey that year was estimated at only 46%. It is thought that this low percentage was due to the presence of a good year which, as mentioned earlier, appeared in 1957 in the 8.0-8.4 cm length group and continued in subsequent years to be of importance (see page 22). It would appear that the heavy fishing of 1959 produced little change in 1960 when, with reduced effort, the total mortality only rose to 56%. The year 1961 was one

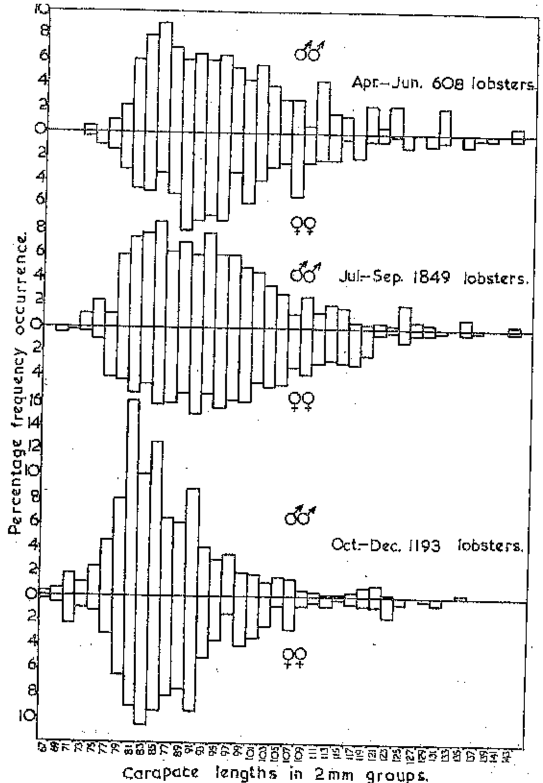


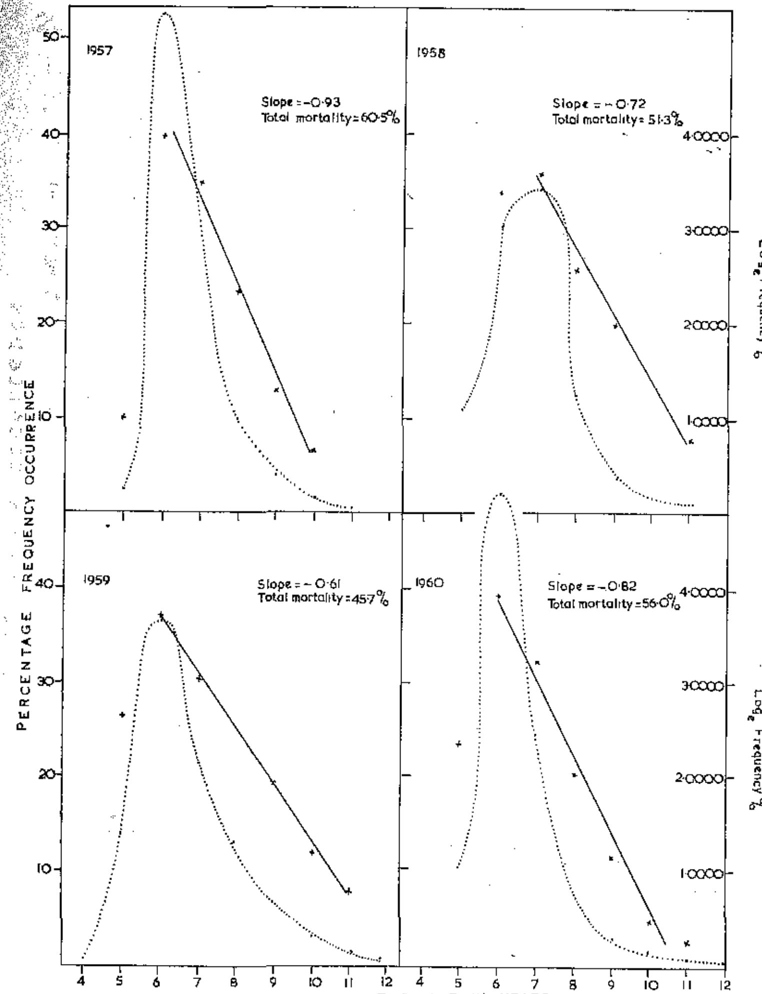
Fig. 8

Length frequency distribution of male and female lobsters at Dalkey (1975—1961 combined data) divided into spring-summer (Apr.-Jun.), summer-autumn (Jul.-Sept.), and autumn-winter (Oct.-Dec.) periods of the year.

of drastically curtailed effort, nevertheless mortality remained about 55%. There is also some evidence to suggest from these curves that the fishing intensity on the 8.5-9.9 cm range varies very much from year to year, as in 1957 the slope through the first 2 plots is considerably less than for the remainder of the size distribution. This seems to have been the case in 1958, 1960 and 1961 also, whereas for 1959 there is a suggestion that these size groups were more heavily fished than the older ones, possibly due to the longer than usual fishing season in that year.

The length frequencies for males at Kilmore Quay converted to age are given in Fig. 10. The mortality estimate is on average even less than at Dalkey. The first three plots in each year suggest a smaller mortality amongst the recruit sized lobsters. The fishing season at Kilmore Quay is seasonal, rarely extending into October as at Dalkey. Therefore, the young recruit lobsters in late autumn are not subject to intensive fishing at Kilmore Quay.

Females. The length frequencies in female lobsters are given in Fig. 7. They are obviously quite unlike the relevant male frequencies



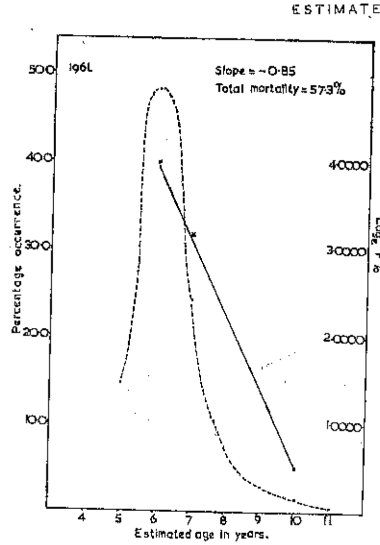


Fig. 9

Apparent total mortality as estimated from male length frequencies converted to age, in the sampled c a t c h, *annually from* 1957 *to* 1961 *at Dalkey.*

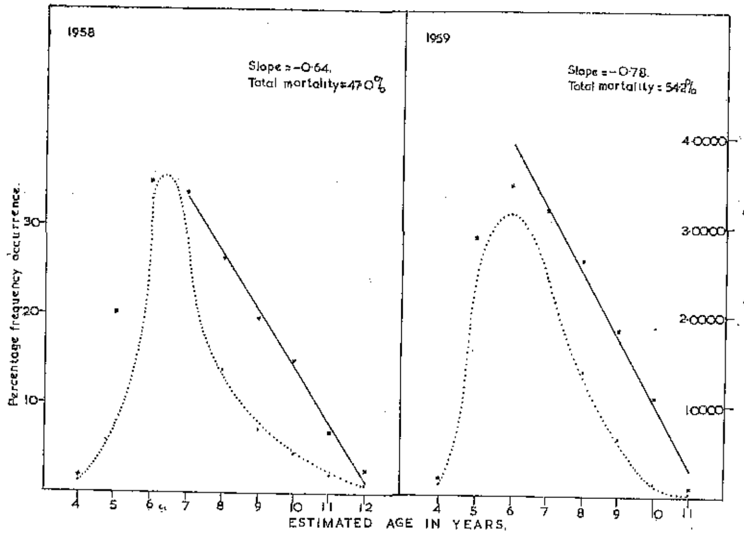


Fig. 10

Apparent total mortality as estimated from male length frequencies converted to age, in the sampled catch at Kilmore Quay, in 1958 and 1959.

offering little evidence of the strength of size classes and showing considerable variation in peak occurrence. The Dalkey data arise from observations made over the whole year and whilst they are not numerous they are based on over 1/5th of the total females landed. The Kilmore Quay samples were taken only in the months from July to Sepember and hence have a rather flat appearance, primarily due to the effects of moulting. Moulting and egg bearing probably account for the featurelessness of the female length distributions and no estimate of mortality is worthwhile using these data.

Discussion. Beverton and Holt (1959) have suggested that total mortality from length distributions may be obtained by using the notation that, $Z = \frac{K(L^{\infty} - 1)}{1 - 1_c}$, where 1 is the mean length of lobsters caught and 1_c is the length at which lobsters are first fully exposed to fishing. In the case of Dalkey lobsters, the mean length is 9.25 cm and the length at which lobsters appear to be fully available is 8.1 cm. Therefore, an estimate of total mortality is as follows:—

$$Z = 0.121 \frac{(174.3 - 92.5)}{92.5 - 81.0}$$
$$= 0.121 \frac{81.8}{11.5}$$
$$= .8603$$

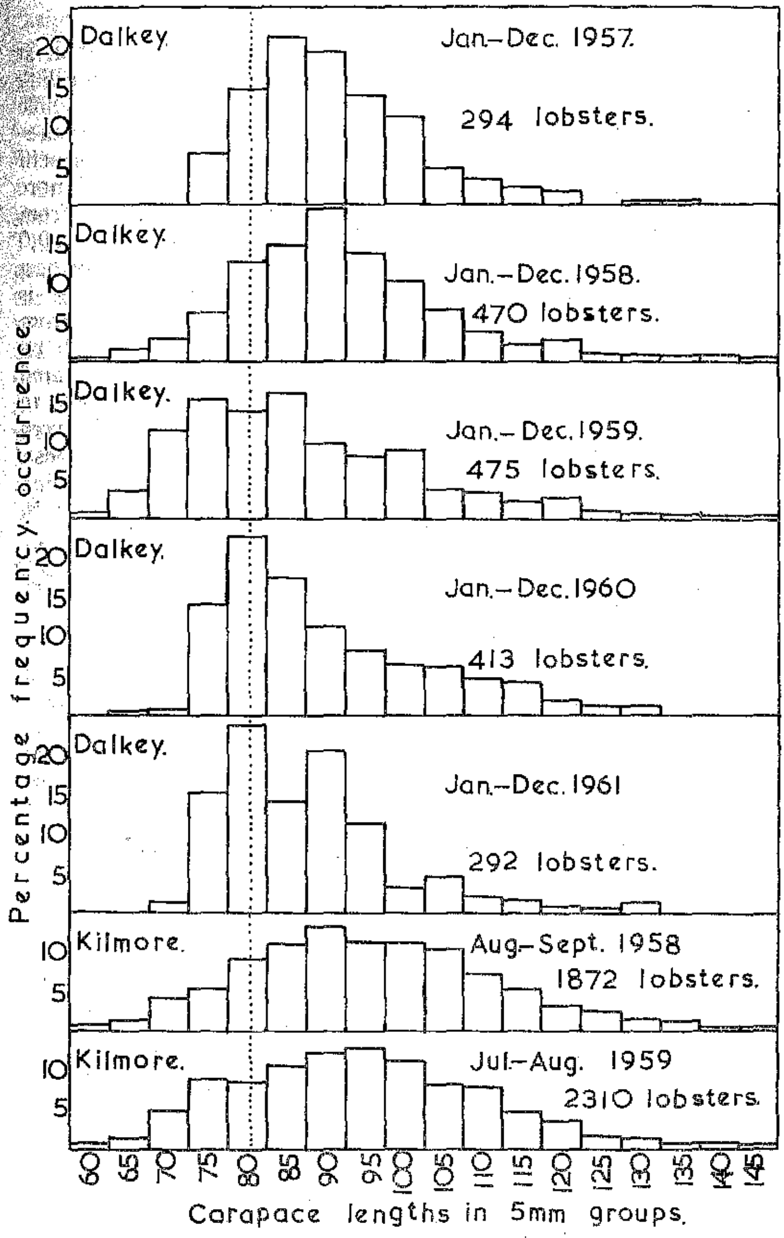


Fig. 7

Length frequency distribution of female lobsters at Dalkey (1957 *to* 1961) *and Kilmore Quay* (1958 *and* 1959). *Dotted line indicates the minimum legal size limit.*

This is equivalent to a total mortality of about 58% which is not at variance with the results obtained from plotting the exponential decline of numbers with estimated age.

Comparing the overall size of lobsters at the two ports it may be seen that the mean is considerably greater at Kilmore Quay than at Dalkey. This is partly due to the time of year at which sampling took place in the two areas. At Dalkey, observations over the whole year tend to show a better cross section since they include measurements of the small lobsters entering the fishery in autumn and present in the catches then and in the following spring. However, at Kilmore Quay, if the measurements are broken down into those arising from small, medium and large boats, the peak moves from 8.5 to 9.0 and 9.5 cm for these boats, respectively. The largest boats fish furthest from shore, sometimes but not always in the deepest water. It is difficult to explain the relatively low total mortalities estimated from these data. The material has been collected from the total catch by each boat. If catches are related to boat size and mortalities estimated on this basis, there is a tendency for that caused by small boats to be greater than that by larger boats. If lobster stocks are very localised and more or less sedentary, as tagging results would suggest, then small boats will tend to concentrate more on a restricted fishing area, whereas larger boats will tend to choose more extensive grounds.

Therefore, so far as these results are concerned it appears that the rate of exploitation of stocks in the two areas studied tends towards underfishing and suggest that they could withstand a considerably greater rate of exploitation.

Mortality curves for females have not been attempted. The habit of egg-carrying, which may last for 10 months, means that a very much larger number of observations are necessary before females may be examined for growth and mortality. Notwithstanding this, the male data probably serve as indicators of the general position of the stock. If any group of animals within a stock is not available for sampling, this will cause certain bias in the conclusions drawn. If the females are not randomly represented in samples during the period May to August then calculations of mortality cannot be reliable and the actual number of egg-bearing females in the stock cannot be estimated with confidence. Moulting itself will cause bias in randomising samples of both sexes so that in the case of males also the conclusions are probably not as precise as would be expected.

Catch Per Unit Effort

The basic unit of effort in lobster fishing is the physical action of raising one pot, creel or trap off the sea bed and bringing it on board. There are a number of possible ways in which the fishing gear may be handled by fishermen. For example, the pot or creel may be so constructed that a lobster once entering it is very unlikely to escape. Such a fishing unit is the American lobster trap. This has a parlour which the lobster enters from which it has great difficulty escaping. Such creels may fish for more than one or two days and are reported to catch more than one lobster per trap on average. They are not used extensively in Ireland, probably because their cost is considerable and expensive hauling gear is necessary to raise them from the sea. The second type of pot or creel is of the intermediate kind from which escape is possible. In Ireland these are specifically used as lobster pots or creels and not to catch other shellfish, except possibly crabs. The third type of fishing gear, the most popular in Ireland, is the French crawfish creel. This gear, it must be remembered, was designed for the purpose of catching crawfish which are more active by day than lobsters. Therefore, whilst their very large entry points allow lobsters and crawfish to enter without hindrance, these same large entries become large outlets to a lobster or crawfish within the creel. To prevent escapes, crawfish creels must be fished often, as much as six to eight times per day if weather permits.

It is necessary to compare the relative efficiency of lobster pots and crawfish creels in some terms which equate them to each other. This is best done by considering the yield from these two types of gear in terms of catch per unit effort. In this case the unit chosen is the number of lobsters per 100 pot or creel hauls. It is thus possible to compare the two gears fairly, and to compare the catches by different classes of boat. From 1958 to 1964 catch records were obtained on a monthly basis where possible and the results are shown in Table 2. In the case of the Dalkey returns it may be seen that the season extends from May to November, thus indicating how profitable it can be to extend the normal Irish fishing season. The Dalkey material also shows that there is a slight fall in the yield during July. This is probably due to a large scale hatching followed by a widespread moult in that month. The Dalkey catch per unit of effort relates to small punts with outboard motors. In 1963 and 1964 further returns were collected from two 4.3 m (14 feet) punts on the south coast (Table 2). These punts used crawfish creels and the immediate result shown is the great increase in the number of hauls when compared with Dalkey. It will be seen from Table 3 that they raised their creels 17,482 times in five months of 1963, and 15,040 times in three months of 1964, compared with three boats in the Dalkey area, raising a similar number of creels per boat, on average, 5,770 times for nine or ten months of the year. This means the south coast punts raised all their creels 3,536 times a month for a total catch of 966 lobsters in 1963, and 5,013 times per month for a total catch of 1,680 lobsters per boat in 1964. On the other hand, the Dalkey punts raised all their lobster pots on average 620 times per month for a total average catch of 1,578 lobsters.

Taking the next category of boat, that from 7.6 to 10.4 m (25′ to 34′) it is also possible to make a comparison. Details of the catch of five boats using crawfish creels on the west coast in 1963 were obtained. They raised their creels 45,820 times in 6 months and caught 567 lobsters per boat. In 1958, 1959 and 1964, six similar sized lobster boats, using lobster pots at Kilmore Quay, raised their gear 18,176 times for an average total catch of 513 lobsters per boat. Although this indicates that for considerably greater effort the crawfishfish creels only produce slightly more lobsters, the years were different and, therefore, the comparison is not as satisfactory as it might be. Above 10.7 m (35′) most boats fishing creels do so with the intention of catching both crawfish and lobsters which, of course, affects the pattern of the returns. Those boats of 15.2 m (50′) and over expressly fish for crawfish and, therefore, are no basis for comparison.

The differences between lobster pot and crawfish creel catches have been plotted in Fig. 11. There is agreement in the case of lobster pots where the yield per boat for punts, boats of 7.6 to 10.4 m (25′ to 34′) and 10.7 to 13.4 m (35′ to 44′) seems to fall along apparently straight lines of ascending order of magnitude with increasing effort.

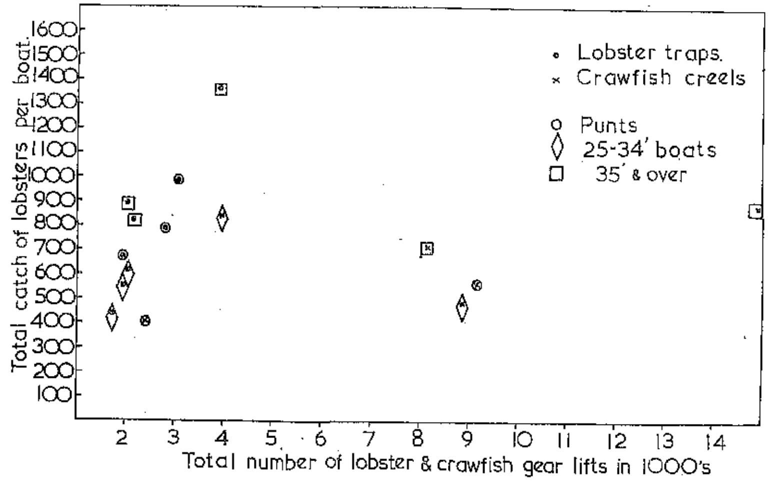


Fig. 11
The catch of lobsters in crawfish crels compared with those in lobster traps by different boat categories, in terms of numbers per 100 lifts, from both Dalkey and Kilmore Quay.

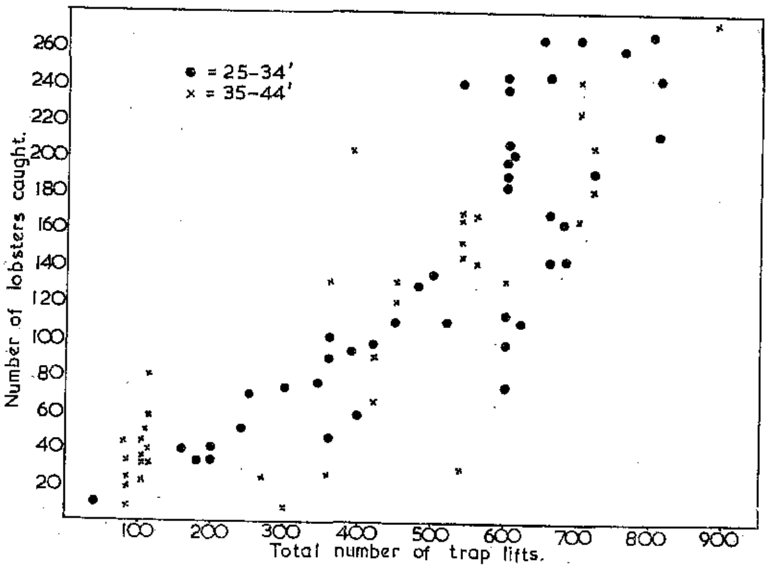


Fig. 12
Catch of lobsters in lobster traps by different boat categories, from both Dalkey and Kilmore Quay, in terms of numbers per 100 lifts.

There is a decided indication that the best yield for effort is made by the 7.6 to 10.4 m (25′ to 34′) boats. Also in Fig. 11, the same material for crawfish creels has been plotted but no definable pattern emerges. In Fig. 12, the catch of lobster in lobster pots has been plotted against the total effort and the scatter of the observations is not very great. However, in Fig. 13, the daily catch from crawfish creels has been plotted against the daily number of hauls and from the scatter it is obvious that there is no constant relationship between boat size and the catch, in relation to this gear.

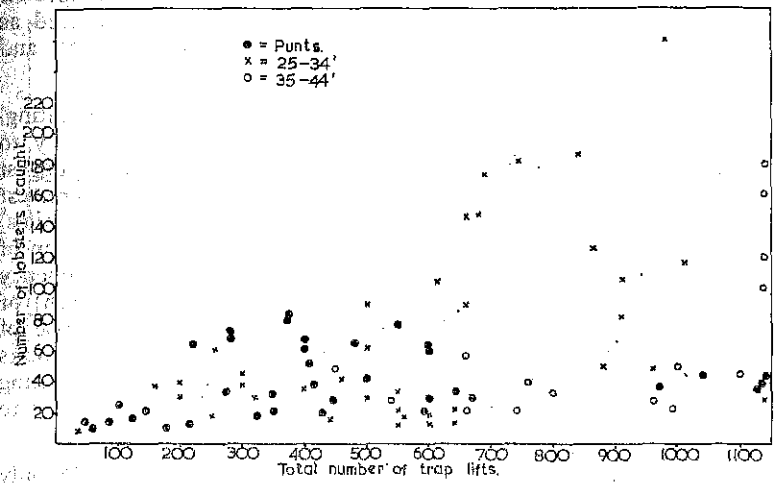


Fig. 13

Catch of lobsters in crawfish creels by different boat categories, from boat Dalkey and Kilmore Quay, in terms of numbers per 100 *lifts.*

There is considerable evidence to show that fishing for lobsters and crawfish will be most efficient when segregated, i.e. lobster gear being used for lobster fishing and crawfish gear for both species but with the emphasis upon crawfish.

Tagging and Marking

At Dalkey. In 1957, lobsters were liberated with numbered celluloid discs wired to the right cheliped. In 1958 and 1959 external tags were discontinued in favour of uropod mutilation according to different coding so that recaptures from each year could be distinguished. In 1960 a plastic arrow tag was inserted into the left side of the suture between the cephalothorax and the first abdominal segment.

After moulting the discs were lost. It is interesting to note that 3 lobsters were recaptured a year later and that these had not moulted. One of these, a male of 10.0 cm length, was not recaptured until 18 months later. The other two consisted of a 10.2 cm male and a 10.3 cm female, both of which failed to moult during the summer of 1958 and were recaptured in March 1959.

Uropod mutilation produced a marked increase in the number of second year recaptures but disappointingly few in the third year. Presumably by then the scars had so healed as to be unobserved. The arrow tag produced good results from one to four years later.

The monthly recaptures for each year from 1958 to 1960 at Dalkey are given in Table 3, where they are divided into males and females and both are expressed as a percentage of the total number of tags unaccounted for at the beginning of each month subsequent to tagging and release. The catch per unit effort is also included in Table 3. The figures for 1957 have been omitted because no catch/effort data had been collected. There are considerable advantages in releasing tagged lobsters early in the year. A total of 49 lobsters were recaptured from the 1959 releases and of these 31 or 63% were recovered as previously moulted. Comparable recaptures of moults for 1958 and 1960 were 19% and 38%, respectively.

Lobster tagging provides information on movements and moulting. Reliable estimates of fishing and natural mortalities are unlikely to be obtained using the present tagging techniques. The results suggest that lobsters do not undertake migrations as adults. The greatest distance travelled, as shown by these experiments, was 8 Km (5 miles) and over 80% of the recaptures were made in or near the location of liberation. The most valuable information regarding moult frequency is likely to be obtained by liberating early in the year (March) or late (November), or throughout the fishing season. In the case of liberation during the season, all recaptures, moults or non-moults may be returned to the sea which would enable the time or moulting and the number of times lobsters of various sizes moult annually to be determined with more accuracy.

So far as mortality estimates from tagging are concerned, the only year which provides three or more seasons of recaptures is 1960 (Table 3). Recaptures from this release, i.e. 69 in 1st season, 23 in 2nd season and 2 in 3rd season would suggest an overall mortality of over 70%.

Ricker (personal communication) has analysed the data for the three years, 1958 to 1960. The mean instantaneous rate of disappearance of tags is 1.95 and the mean survival rate is 0.15, based on sums of numerators and sums of denominators. The corresponding geometric mean survival rate is 0.142. This suggests a total mortality of about 86%, which seems to be high. Taking the 1960 data we find that the rate of exploitation of the stock from 1960 to 1961 is $77/275 = 0.280$, the instantaneous rate of disappearance of tags is 1.63 and the survival rate is $15/77$ or 0.195. Therefore, the fishing mortality, $F = 0.280 \times 1.63/0.805 = 0.57$, suggesting an excessively high natural mortality. It is probable, therefore, that there is a very considerable early death rate due to tagging. If natural mortalities of 0.1, 0.2 and 0.4 are assumed for each of the years from 1958 to 1960 and the notation is employed whereby $N = \frac{F}{Z}(1-e^{-z})$ equals the number recaptured in each year after tagging, then the most likely estimate of immediate mortality due to tagging is 40 (19%) in 1958, 30 (22%) in 1959 and 70 (25%) in 1960. Apparently suture tags cause the greatest instantaneous mortality whereas with uropod mutilation the mortality is 3% to 6% lower.

Body Measurements

Throughout this paper the length measurement used is that of the carapace. This is now the official measurement in Ireland for the minimum legal size limit below which lobsters must be returned to the sea. The size limit is set at 83 mm for both males and females. Irish fishermen have been presented with stamped bronze gauges to assist them in rejecting undersized lobsters from their catches.

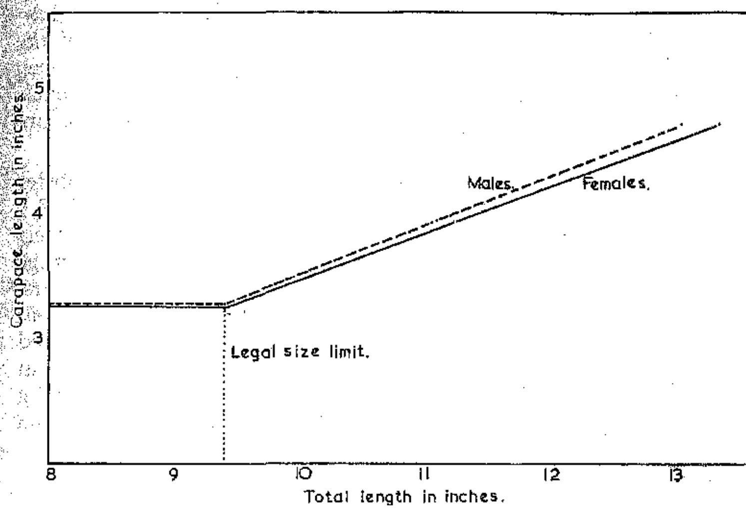


Fig. 14
Relationship of carapace to total length of male and female lobsters in inches and converted from metric regression equations.

The carapace was measured to the nearest mm below using a vernier calipers, one leg of which was placed at the back of the eye socket and the other leg at the distil margin of the carapace. This method of measurement was adopted because it is faster and more accurate than that taken from the tip of the rostrum to the margin of the tail fan. There is a very high degree of correlation between the carapace and total length. Thus it is possible to convert carapace measurements reliably into total length. Over one thousand lobsters of both sexes and covering a wide range of lengths were measured for both carapace and total length. The resulting correlation produced the following regression equations for Irish male and female lobsters (Fig. 14):

Males	$L=2.483C+32.66$
Females	$L=2.636C+20.16$

where L=total length and C=carapace length. Similar regressions for Scottish and Welsh lobsters obtained by Pope (1955) and Simpson (1961) are:—

Scottish Lobsters

Males	$L=2.507\ C+25.9$
Females	$L=2.678\ C+15.4$

Welsh Lobsters

Males	$L=2.463\ C+29.5$
Females	$L=2.692\ C+13.4$

The relationship produced by these three equations show that there is very little difference between the three sets of figures.

Weight

Regression equations for converting given carapace length to weight have not been calculated. It was found that the weight varied very much, presumably dependant upon the condition of particular lobsters. A very large number of observations have been recorded of the average weight of lobsters caught and sold. Other data have been collected to determine the individual weight for length in both sexes. A small number of data have been collected of weight before moulting and weight gain after moulting (Gibson, 1963).

A total of 51 samples comprising 8,935 lobsters caught by lobster pots weighed 6,944 Kg (15,2768 lbs.) or an average weight of 777 g (1.71 lbs.). In comparison, 59 samples comprising 3,290 lobsters from crawfish creels, weighed 1979 Kg (4,363 lbs.) or an average weight of 602 g (1.33 lbs.) per lobster. The majority of these lobsters, caught in crawfish creels, were taken from inshore waters in about 5.5 to 9.1 m (3 to 5 fathoms). When those lobsters were extracted which were caught by vessels fishing deeper water from 9.1 to 27.4 m (5 to 15 fathoms), the average weight increased from 602 to 668 g (1.33 to 1.47 lbs.). Nevertheless it appears that crawfish creels on this evidence, tend to yield a slightly lighter lobster.

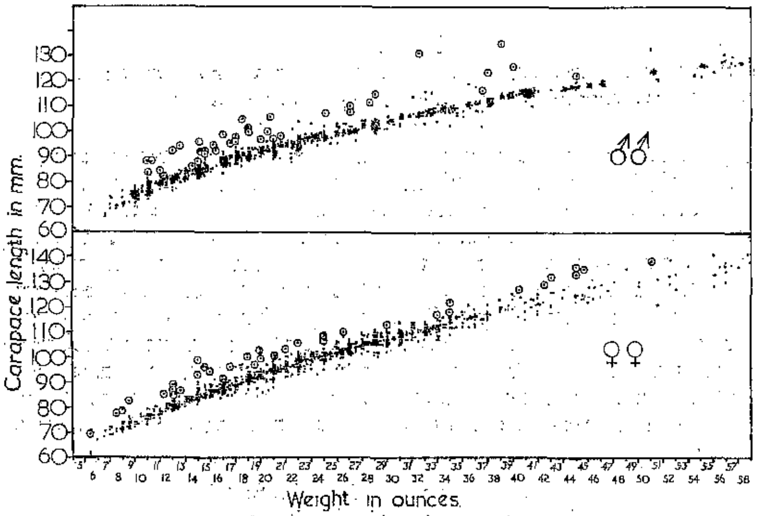


Fig. 15

Relationship of length to weight in male and female lobsters. Circled dots are individual lobsters which had lost a cheliped.

Individual weights for lengths were observed for just over 3,500 lobsters of both sexes. The plots for these data are given in Fig. 15. It was noted that practically all males which had only one or no claws, when weighted, were, quite unexpectedly, the heaviest in their respective length groups. The legal size limit for males is 83 mm and is equivalent to a mean weight of 312 to 340 g (11 to 12 ozs.). *Similarly in the case of females (Fig. 15) the one- or no-clawed* individuals were almost invariably the heaviest in their size categories. While the smaller lobsters of both sexes appear to have similar weights length for length, males over 510 g ($1\frac{1}{2}$ obs.) appear to be considerably heavier than females of equal length.

Approximate weight for lengths are as follows: —

Carapace lengths cm	7.0	8.0	9.0	10.0	11.0	12.0	13.0
Male	213 g ($7\frac{1}{2}$ ozs)	333 g ($11\frac{3}{4}$ ozs)	510 g (18 ozs)	709 g (25 ozs)	992 g (35 ozs)	1.30 Kg (46 ozs)	1.64 Kg (58 ozs)
Female	220 g ($7\frac{3}{4}$ ozs)	340 g (12 ozs)	482 g (17 ozs)	680 g (24 ozs)	879 g (31 ozs)	1.11 Kg (39 ozs)	1.42 Kg (50 ozs)

From the formula on page 18, the length increase for males and females at each moult commencing at 7.0 cm in the two sexes is as follows: —

	1st moult	2nd moult
Males 7.0 cm	7.93 cm	8.92 cm
Females ,,	7.89 cm	8.85 cm

Thus the approximate weights for these size increases as estimated from the plot in Fig. 15 are as follows: —

Males

Length		Weight	Increase	% Increase
7.0 cm	=	213g(7.5 ozs)	113g(4.00 ozs)	53
7.9 cm	=	326g(11.50 ozs)	128g(4.50 ozs)	39
8.9 cm	=	454g(16.00 ozs)		

Females

Length		Weight	Increase	% Increase
7.0 cm	=	220g(7.75 ozs)	135g(4.75 ozs)	62
7.9 cm	=	355g(12.50 ozs)	135g(4.75 ozs)	38
8.9 cm	=	490g(17.25 ozs)		

Therefore, from 7.0 cm and 8.3 cm (the present size limit), the weight increases from about 213 g ($7\frac{1}{2}$ ozs.) to 369 g (13 ozs.) or approximately 73%, which illustrates the great benefit of returning undersized lobsters to the sea.

Maturity

Templeman (1935b) and Simpson (1961) drew attention to the fact that at the onset of maturity there appears to be a distinct enlargement of the width across the second abdominal segment in females. Simpson (1961) showed that in Welsh lobsters, even before the moult preceding first egg-bearing, the width across the second abdominal segment starts to increase relative to the carapace length. He concluded the mean carapace length of lobsters maturing for the first time to be 8.6 cm. The relationship of abdominal width to carapace length in the case of maturity was not studied in the Irish data. However, the observations of egg bearing females would lead to the conclusion that lobsters on the Western side of the Irish Sea probably mature and become ovigerous earlier than on the eastern side. The actual details are given in Table 4. Whilst the data in this table are not as extensive as the material of Simpson (1961) they do show that up to a carapace length of 8.4 cm, 8.5% of females examined were ovigerous. It is clearly evident that sampling of the smaller size groups, particularly up to 8.4 cm, represents only a small fraction of the individuals in the stock of these sizes and, therefore, the author hesitates to attempt to fix the minimum size of females at maturity. However, the mean minimum size at which *all* females may be expected to mature is within range 8.0 to 8.9 cm.

The percentage occurrence of egg-bearing (ovigerous) females varies in the case of Dalkey from year to year. For the years 1957, 1958, 1959, 1960 and 1961, th percentage females bearing eggs in the over-all catch was, 29.3%, 23.0%, 33.2%, 19.0% and 32.0%, respectively. The normal ratio of females to males in the catches is approximately 55% to 45%. The time of year at which egg-bearing females appear

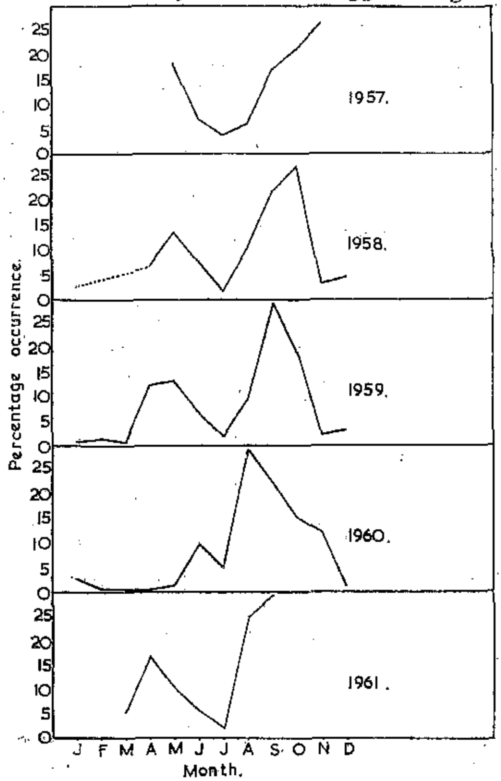


Fig. 16

Percentage occurrence of ovigerous females in the catch at Dalkey (1957 to 1961 combined data).

in the catches has been plotted in Fig. 16 for Dalkey for the years 1957 to 1961. The apparent feature of these diagrams is the occurrence of double peaks each year, one in the spring, April or May, (except in 1960 when it occurred in June) followed by a second in the period August to November. The second feature of the curves is the annual scarcity of egg-bearing females in July. In July the ratio of females to males becomes of the order of 35 to 65, and thus it may be that in July females are not taken in the catch because they are engaged in the process of preparing to discharge their hatching eggs. If, therefore, it is assumed that the gradual reduction of berried females in the catches from April onwards is due to preparation and the actual process of hatching the eggs, then the spring peaks could be joined on to the summer peaks, to estimate the true representation of egg-bearing females in the stock as opposed to samples.

Female lobsters appear to carry their eggs for a considerable period. When the eggs first emerge from the oviducts they are ebony black, shiny and quite sticky to the touch. They are also very easily removed at this stage, and can be termed as *new*. After a few months the eggs turn reddish brown in colour and the larval lobster can be seen developing within the transparent egg covering. They are then difficult to remove because they are bound together in clumps by colourless membranes. They can be termed as *incubating eggs*. Later the eyes of the larvae are plainly visible as large black spots, and the eggs can be very easily removed. At this stage the eggs are *hatching*. Females bearing eggs of these three different stages have been segregated and their distribution is shown in Figs 17 and 18 for Dalkey and Kilmore Quay. The Kilmore Quay data include data obtained from commer-

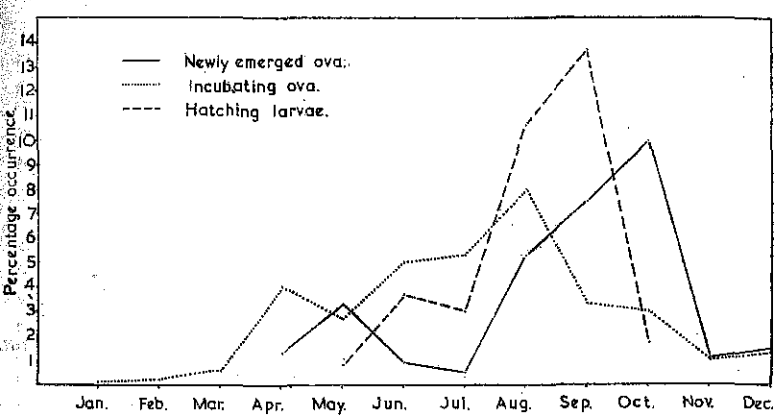


Fig. 17

Percentage occurrence of lobsters bearing new, incubating and hatching ova (1957 *to* 1961 *data combined*), *at Dalkey.*

cial samples which were examined for egg-bearing females only in the months of March and April. Figs. 17 and 18 would suggest that there is an abundance of hatching in the months of August and September at Dalkey, and July and August at Kilmore Quay with fair numbers also in the March to June period. The sequence of the life history after the females have moulted is recounted by Dow (1964) as follows:—

"Shortly after moulting, while the new shell is soft, the mature female is impregnated by a hard-shelled male. Following approximately a year, the eggs are extruded from the ovaries and fertilised by the sperm which has been retained in the seminal receptacle . . . During the warm months of the following year the eggs complete incubation and hatch." This description applies to *H. americanus* in

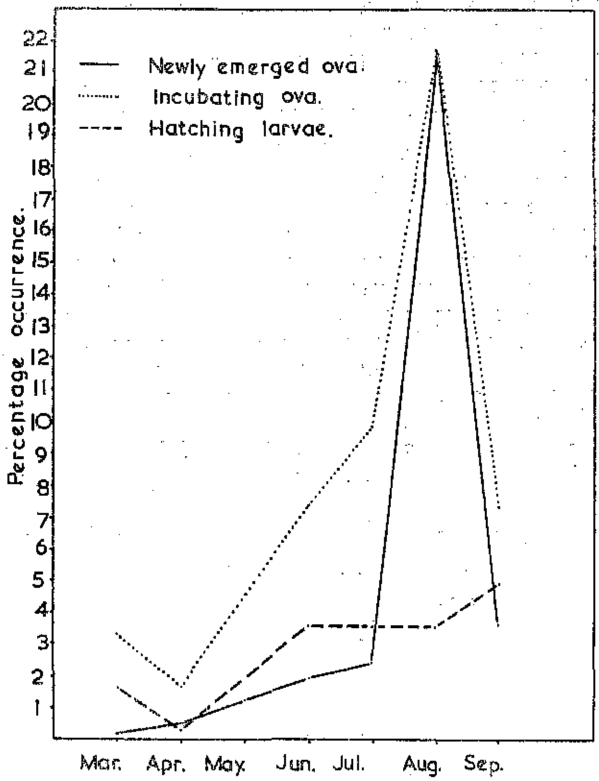


Fig. 18

Percentage occurrence of lobsters bearing new, incubating and hatching ova (1958 *and* 1959) *at Kilmore Quay.*

which species mature females carry the male sperm for nearly 12 months, and the eggs for a further period which may be less than a year. Thus if a female were fertilised in August, 1960, she might extrude the eggs by July 1961 and these could hatch by the late spring of 1962. Equally the sequence could be such that eggs would emerge in the early spring.

In the case of Dalkey fresh sticky eggs appear on the females in some quantity in May but are most common in October, while incubating eggs are more or less well represented in samples from April to October (Fig. 17). At both Dalkey and Kilmore Quay the most marked occurrence of hatching eggs occurs in August or September (Figs. 17 and 18).

Some of the freshly emerged eggs in the August and September period are attributable to those females in the 7.5 to 8.5 cm length group which presumably are becoming ovigerous for the first time.

Pathology

At one centre, in 1961, where lobsters were stored in ponds, heavy unexplained mortality took place. Samples of dying lobsters were transferred to the Pathology Department of Unversity College, Cork. From them the tetrad bacterium, *Micrococcus tetragenus* Gaffky was isolated. This had been reported by Snieszko and Taylor (1947), Getchell (1949) and Roskam (1957) as the causative organism of a blood disease of lobsters called *Gaffkaemia,* which caused widespread mortality in stored lobsters on both sides of the Atlantic. Studies of sections of various lobster tissues affected by the disease showed the bacteria to be concentrated particularly in the gills, more so than any other organ, but absent from the alimentary canal. The reaction of the respiratory cells to the organism was similar to that in the human lungs in the presence of the pneumonia bacillus. During experimental work it was found that when diseased lobsters were isolated and kept in well aerated conditions, they lived longer than under less favourable oxygen conditions. It was also observed that when fresh consignments of unaffected lobsters were introduced to the storage pond, a period of about 10 days had to elapse before *M. tetragenus* could be isolated from their tissues. An "explosion" of the disease took place amongst them some 18 days later.

Lobsters were examined from many parts of the Irish coast before storing and samples of their blood were taken. A very high incidence of a tetrad coccus was found in these lobsters direct from the sea. This organism was subsequently examined in the Laboratory at Burnham-on-Couch, Essex, England, and confirmed not to be the bacterium responsible for Gaffkaemia. Out of a total of 279 lobsters examined from all parts of the coast only one positive field identification of *M. tetragenus* was made and that in the case of a lobster which had been caught less than one mile from the outlet pipe of the lobster pond referred to above. Presumably when the organism is prevalent in a storage pond, the outflowing water from such a pond will tend to establish high densities in nearby seawater. The low incidence of infected lobsters in the field suggests that under natural conditions the disease is very rare. However, when lobsters are subjected to the unnaturally high density conditions in storage ponds where there has been an outbreak of the disease at any time infection rates rise rapidly. In the field, the occurrence of the disease was found to be of the order of 0.03%, whereas in the lobster ponds in question it was approximately 12.5% at the stage when it had reached epidemic proportions. A number of tests were carried out to determine if the disease was more of less prevalent in particular lobsters. This revealed that one-clawed lobsters were the most readily infected but that apparently undamaged lobsters were prone to succumb also. There was no difference in resistance to the disease by females or males. Resistance to the disease seemed to be greatest in the case of recently moulted lobsters and least in lobsters about to moult and there were no differences between males and females.

Much remains to be solved concerning the pathology of this disease, particularly with reference to its portal entry, its adaptability to temperature and reaction to anti-biotics. Roskam (1958) reported that the organism was retarded at temperatures below 7°C and that in these conditions infection in ponds was severely reduced. The evidence from Irish investigations seems to point to the fact that little or no trouble may be experienced during the first week after lobsters have been introduced to a pond.

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Table 1.—Comparison of lobsters caught by three kinds of trap

Centre	Type of gear	Diameter of eye	Carapace length			No. of lobsters examined
			Average mm.	S.D. mm.	Coefficient of variation %	
Co. Wexford	Modified "Ink well"	15.9cm (6¼″)	9.725	1.460	15.0	200
Co. Waterford	Modified Scottish creel	16.5cm (6½″)	9.755	1.209	12.4	211
Co. Kerry	French crawfish	27.9cm (11″)	10.896	2.002	18.4	190
Co. Dublin	Modified Scottish creel	11.4cm (4½″)	9.456	1.102	11.6	276
All areas ...		17.9	9.773	1.4193	14.5	877

Table 2.—Catch per unit effort by punts, 25-34′, 35-44′ and 45-50′ boats

Those marked ø are lobster pots and
those marked x are crawfish creels.

Figures in brackets represent the number of boats co-operating

Year	Boat size	Duration of fishery or experiment	Total catch	Catch per boat	Total No. of pot or creel hauls	Centre
1958	14′ punts (3)	9 months	1314	438	5,190 ø	Dalkey
1959	14′ punts (3)	10 months	1845	615	6,150 ø	Dalkey
1960	14′ punts (3)	9 months	1674	558	5,972 ø	Dalkey
1963	14′ punts (2)	5 months	966	483	17,682 x	Cork
1964	14′ punts (2)	3 months	1680	840	15,040 x	Cork
1958	25-34′ (2)	2 months	1783	891	4,226 ø	Kilmore
1959	25-34′ (3)	3 months	4094	1365	11,770 ø	Kilmore
1963	25-34′ (5)	6 months	2834	567	45,820 x	West Coast
1964	35-44′ (6)	2 months	5963	994	18,360 ø	Kilmore
1964	35-44′ (3)	3 months	1235	412	7,278 x	Various
1963	35-44′ (1)	4 months	712	712	8,135 x	West Coast
1959	35-44′ (1)	3 months	683	683	1,935 ø	Kilmore
1964	35-44′ (5)	2 months	3981	796	14,170 ø	Kilmore
1963	45-50′ (2)	6 months	1790	895	30,520 x	Kerry
1964	25-34′ (1)	2 months	820	820	2,180 ø	Kilmore

Table 2—(continued)

Year and Centre	Monthly catch of lobsters per 100-pot or creel hauls											
	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Dalkey 1958 ...	—	—	—	18	19	23	23	32	30	33	25	25
Dalkey 1959 ...	—	—	20	22	30	36	30	43	39	33	27	19
Dalkey 1960 ...	—	—	—	20	25	33	28	34	41	26	24	22
Cork 1963	—	—	—	—	4	5	4	8	6	—	—	—
Cork 1964	—	—	—	—	—	—	14	16	12	—	—	—
Kilmore 1958 ...	—	—	—	—	—	—	—	43	41	—	—	—
Kilmore 1959 ...	—	—	—	—	—	34	37	33	—	—	—	—
West Coast 1963 ...	—	—	—	4	6	7	5	9	6	—	—	—
Kilmore 1964 ...	—	—	—	—	—	—	—	31	34	—	—	—
Various 1964 ...	—	—	—	—	—	—	17	14	20	—	—	—
West Coast 1963 ...	—	—	—	—	—	4	10	9	12	—	—	—
Kilmore 1959 ...	—	—	—	—	—	34	32	40	—	—	—	—
Kilmore 1964 ...	—	—	—	—	—	—	—	30	26	—	—	—
Kerry 1963	—	—	—	—	5	7	6	5	8	4	—	—
Kilmore 1964 ...	—	—	—	—	—	—	—	42	33	—	—	—

Table 3.—The annual monthly catch of lobster and effort (c/f where available), together with the recapture of male and female lobsters in numbers and expressed as monthly percentage of those unaccounted for, during 1958, 1959 and 1960.

Month	Total catch	c/f	No. released	No. recaptured M	No. recaptured F	% unaccounted
	1958 No. released = 207 in July					
January	90	—		—	—	
February	87	—		—	—	
March	95	—		—	—	
April	105	18		—	—	
May	130	19		—	—	
June	260	23		—	—	
July	232	23	207	7	—	96.6%
August	500	32		25	17	76.3%
September	480	30		4	4	72.5%
October	390	33		2	5	69.1%
November	310	25		1	—	68.6%
December	350	25		—	1	68.1%
	1959 No. released = 139 in March					
January	290	—		—	—	
February	270	—				
March	285	20	139			
April	320	22		4	3	95.0%
May	360	30		4	7	87.9%
June	430	36		2	1	84.9%
July	431	30		2	1	82.8%
August	435	43		9	5	72.7%
September	600	39		—	—	—
October	504	33		—	2	71.3%
November	260	27		—	—	—
December	120	19		—	—	—
	1960 No. released = 275 in June					
January	52	—				
February	68	—				
March	78	—				
April	176	20				
May	372	25				
June	762	33	275			
July	671	28		14	13	90.2%
August	676	34		11	18	80.0%
September	486	41		2	5	77.1%
October	126	26		1	1	76.3%
November	196	24		1	1	75.5%
December	246	22		1	1	74.7%

Table 4.—Distribution of ovigerous females of different sizes

Year	1957	1958	1959	1960	1961	Totals	%	% of numbers examined in each size group
Carapace length in size groups of 5mm								
70–74	—	—	—	1	—	1	0.25	3.3%
75–79	1	1	—	1	—	3	0.68	1.8%
80–84	8	5	5	8	7	33	7.55	10.8%
85–89	9	9	16	7	6	47	10.73	16.5%
90–94	14	25	22	9	10	80	18.23	22.8%
95–99	14	22	21	10	11	78	17.78	36.3%
100–104	4	28	14	13	3	62	14.14	40.5%
105–109	5	14	19	7	7	52	11.84	43.7%
110–114	3	5	7	6	4	25	5.70	35.7%
115–119	2	4	6	5	2	19	4.34	35.2%
120–124	1	6	6	3	1	17	3.87	42.5%
125–129	—	4	6	1	2	13	2.96	86.7%
130–134	—	3	1	2	—	6	1.37	54.5%
131–139	1	—	1	—	—	2	0.46	15.0%